

10/597539

Document made available under the Patent Cooperation Treaty (PCT)

International application number: PCT/US05/003215

International filing date: 03 February 2005 (03.02.2005)

Document type: Certified copy of priority document

Document details: Country/Office: US
Number: 60/542,736
Filing date: 06 February 2004 (06.02.2004)

Date of receipt at the International Bureau: 03 March 2005 (03.03.2005)

Remark: Priority document submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b)



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APPLICATION NUMBER: 60/542,736

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Express Mail Label No. EL 734727896 US

322782 U.S. PTO
60/542736

22102 U.S.F.
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Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)			
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Additional inventors are being named on the _____ 1 _____ separately numbered sheets attached hereto					
TITLE OF THE INVENTION (500 characters max)					
: Integrated panoramic and forward optical system for omnidirectional signal processing					
Direct all correspondence to: CORRESPONDENCE ADDRESS					
<input type="checkbox"/> Customer Number: <div style="border: 1px solid black; width: 300px; height: 40px; display: inline-block;"></div>					
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ENCLOSED APPLICATION PARTS (check all that apply)					
<input checked="" type="checkbox"/> Specification Number of Pages 9		<input type="checkbox"/> CD(s), Number _____			
<input checked="" type="checkbox"/> Drawing(s) Number of Sheets 5		<input checked="" type="checkbox"/> Other (specify) assignment record.			
<input type="checkbox"/> Application Data Sheet. See 37 CFR 1.76					
METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT					
<input checked="" type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27. <input checked="" type="checkbox"/> A check or money order is enclosed to cover the filing fees. #8817 <input type="checkbox"/> The Director is hereby authorized to charge filing fees or credit any overpayment to Deposit Account Number: _____ <input type="checkbox"/> Payment by credit card. Form PTO-2038 is attached.					FILING FEE Amount (\$) <div style="border: 1px solid black; width: 100px; height: 80px; margin: 0 auto; display: flex; align-items: center; justify-content: center;">80.00</div>
The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government. <input type="checkbox"/> No. <input checked="" type="checkbox"/> Yes, the name of the U.S. Government agency and the Government contract number are: US Navy N00014-03-M-0190					

[Page 1 of 2]

Respectfully submitted,

SIGNATURE

omitted.

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TELEPHONE 518-283-7500 x23

Date February 6, 2004

REGISTRATION NO. 43123

(if appropriate)

Docket Number: PP012004

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Docket Number PP012004

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Number 1 of 1

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IN THE UNITED STATES PATENT OFFICE

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Alexandria, VA 22313-1450

Dear Sir:

Transmitted herewith for filing is a **provisional patent application** of inventors:

Michelle Simkulet
Jason Smith
Jiayin Ma

For: Integrated Panoramic and Forward Optical System for Omnidirectional Signal Processing

Included in this mailing are the following items:

- (x) Provisional patent application cover sheet
- (x) Specification (9 pages)
- (x) Drawings (5 sheets)
- (x) Provisional application filing fee of \$80 (check # 8817)
- (x) Assignments of the invention to InterScience, Inc., with recordation sheet and recordation fee of \$40 (check # 8817)

Sincerely,



Michelle Simkulet
Registration # 43123

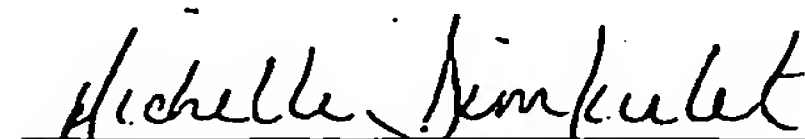
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Michelle Simkulet
(name of person mailing)


(signature of person mailing)

Title: Integrated panoramic and forward optical system for omnidirectional signal processing

Inventors: Michelle Simkulet, Jiayin Ma, Jason Smith

Field of the Invention:

This invention relates to the field of omnidirectional optical systems. The optical system is comprised of two paths, panoramic and forward, seamlessly integrated on a single plane. The total field of view is comprised of the forward field of view and the panoramic field of view.

Background of the Invention:

There are many existing patents for optical systems that provide omnidirectional imaging. We believe we have some unique characteristics that are not covered in any existing patent and that provide a unique new capability to imaging systems and omnidirectional optical components in general. Jeffrey Charles has several U.S. patents on the subject including US patent 6,333,826 and US patent 6,449,103, BeHere Corporation has several US patents including US 6,392,687, US 6,424,377 and US 6,480,229, and Remote Reality has US patent 6,611,282.

The patents by Jeffrey Charles focus solely on the panoramic field of view, and efforts to maximize that field of view for near field applications. The Charles' patents include a frontal exclusion zone of about 60 degrees that can be tapered approaching the far field by the use of a torroidal-shaped reflector. Although this exclusion zone eventually disappears as a point where the boundaries of the panoramic field meet, there is no account in the patent for the overlapping area past the point of convergence in the processing or interpretation of the image. The minor disclosure of including forward optics to image the frontal exclusion zone makes no mention of details of how to match the magnification or the relative F/# of the integrated images as well as a means of interpreting or processing the overlapping images. The mere inclusion of forward viewing lenses does not automatically lend itself to an easily interpretable image. The focus of the optical system is near field prior to the overlap. Although there is provision to include the forward viewing optics to image the frontal exclusion zone, there will only be one point (or one radial distance) in which the frontal zone and the panoramic zone exist with either no gap or no overlap.

The BeHere technology also concentrates on the panoramic field of view and only makes provisions to extend the panoramic view as far forward as possible by changing the shape of the reflector. By placing a dimple in the apex of the parabolic reflector, imaging beyond the secondary reflector is achieved in the far field. These inventions provide no means for forward imaging in the near field.

The Remote Reality invention is a super wide-angle panoramic imaging apparatus that claims up to a 260° vertical field of view using a two reflector configuration. The invention includes an undefined blind spot along the optical axis. The invention claims a single view point while also having a substantially flat and stigmatic image plane.

Below are some summarizing details of each of the patents referenced above.

US 6,333,826 Jeffrey R. Charles

Omniramic Optical System Having Central Coverage Means Which Is Associated With a Camera, Projector or Similar Article

- single and two reflector embodiments
- two reflector embodiment produces frontal exclusion zone ~ 60 degrees
- produces annular image
- minimization of frontal exclusion zone using torroidal shape primary reflector
- achieves far field imaging with triangular shape frontal exclusion zone, beyond point, overlap in annular image
- discloses in specification only (column 26, line 57 - column 27, line 9) use of supplemental lenses in front of secondary mirror transparent area to image area greater than or equal to frontal exclusion zone, produces concentric images
- overlapping images to produce 3D info
- FOCUS: maximization of annular image boundaries, minimization of frontal exclusion zone, far field imaging, overlap of zones to produce 3-D image information

US 6,449,103 Jeffrey R. Charles

Solid Catadioptric Omnidirectional Optical System Having Central Coverage Means Which is Associated with a Camera, Projector, Medical Instrument or Similar Article

- solid optical substrate with primary and secondary internal reflectors and outer surface being convex refracting surface
- combination of primary reflector shape and outer refracting surface allows for imaging a point a finite distance in front of said optical system - thereby allowing for far field imaging only - but also subject to image overlapping beyond that finite point
- purpose of the convex refracting surface, which would be extremely difficult or even impossible to manufacture, is to extend the panoramic field of view boundaries.
- Claims 31-36 deal with solid optical substrate with primary and secondary internal reflectors in which secondary reflector has a transparent central zone with a concave surface or lenses to image central exclusion zone.

US 6,392,687 BeHere Corp.

Method and Apparatus for Implementing a Panoptic Camera System

- Two reflector design
- Main reflector consists of a paraboloid shape with a dimple on the apex such that the main reflector can capture light from behind a second reflector
- Details two cameras together to see an entire sphere and a stereo vision panoptic camera
- Similar to Charles' patent, still leaves a zone just beyond secondary reflector which is not viewable

US 6,424,377 BeHere Corp.

Panoramic Camera

- Single reflector design - mirror is parabolic cone shape
- Includes imaging camera, astigmatism correction lens, field flattening lens and objective lens

- Multiple sensors on same plane in mosaic pattern to achieve desired resolution
- Alternative embodiment 2 reflector design - camera housed within parabolic mirror (ONLY CONFIGURATION CLAIMED)
- Alternative embodiment single and 2 reflector designs whereas the parabolic reflector is the inside surface of a curved block of transparent material with refractive properties
- annular image presentation techniques including conversion to rectangular coordinates
- claims apparatus for capturing panoramic images
- claims apparatus with parabolic first reflector and light capture linearly proportional to angle of incidence on mirror

US 6,480,229 BeHere Corporation
Panoramic Camera

- single reflector convex mirror incorporating a beamsplitter to send annular image to two different electronic image capture devices (ONLY CONFIGURATION CLAIMED)
- Alternative embodiment 2 reflector design - camera housed within parabolic mirror Alternative embodiment single and 2 reflector designs whereas the parabolic reflector is the inside surface of a curved block of transparent material with refractive properties
- annular image presentation techniques including conversion to rectangular coordinates

US 6,611,282 Remote Reality
Super Wide-Angle Panoramic Imaging Apparatus

- two reflector configuration, primary reflector is a hyperboloid and secondary reflector is concave
- achieves up to a 260° vertical field of view which includes an undefined blind spot along the optical axis immediately behind the secondary reflector
- claims image is free of field curvature effects and astigmatic effects
- secondary reflector is an ellipsoidal or spherical mirror
- alternative embodiment includes reflective elements housed in solid optical block
- image mapable into Cartesian coordinate system

Summary of the Invention:

The objective of the present invention is to provide an omnidirectional optical system comprising an integrated panoramic / forward view imaging system that provides a coplanar omnidirectional image to a means of image display and/or recording. The present invention is comprised of a two optical path system that is combined on a single image plane. The present invention achieves matched magnification between the forward and panoramic images, relatively seamless boundaries with no overlap or blindspot, and a total field of view approximating 270 degrees azimuthally (vertically) about the entire 360-degree periphery. The invention can be utilized for surveillance applications as a pole mounted or ground mounted system or implemented in a stand-alone unit. The optical system can be miniaturized for endoscope and borescope implementation or alternatively enlarged for pipe inspection or other large-scale inspection implementations. An alternative non-imaging embodiment of the present

invention can be applied to optical free space communication as an omnidirectional optical antenna.

Brief Description of the Drawings:

Figure 1 is a two dimensional schematic of the optical system of the present invention.

Figure 2 is a two dimensional schematic showing the ray trace of the panoramic component of the optical system.

Figure 3 is a cross-sectional depiction of the fields of view attainable with the present invention.

Figure 4 is a representation of the image on the image plane.

Figure 5 is a two-dimensional schematic of an alternative embodiment of the present invention as an afocal optical system for non-imaging applications.

Figure 6 is a two-dimensional schematic of an alternative embodiment of the present invention that comprises directional zooming capabilities.

Detailed Description:

Purpose and Applications

The present invention has been configured as a means of achieving the widest field of view possible, including rear-viewing capabilities while minimizing distortion and without relying on panning and tilting mechanisms. Current wide field of view, non-moving, optical systems typically consist of fish eye optical systems. The distortion of fish eye optical systems is so great that it is not suitable for many imaging applications. The distortion is created by the non-uniform refraction of the light rays across the field of view. The boundaries of the field of view typically appear much more distorted than the central area of the field of view since the geometry of the optical system is meant to maximize the field of view. Advances in alternative panoramic imaging optical systems presents a means of imaging the periphery, but typically not the entire hemisphere in front of the imager. Single and dual reflector optical systems exist that provide peripheral imaging, but lack forward imaging. Pan and tilt optical systems provide the means to cover the same field of view, but require mechanical motion and do not present the entire field of view in a single instance on the image plane. For many applications the lack of constant viewing of the entire field of view or the requirement of mechanical motion is unacceptable. The present invention has applications that include but are not limited to surveillance, safety monitoring, industrial inspection, and medical endoscopy.

Optical System

The present invention is initially described with reference to Figures 1 and 2. Figure 1 shows the layout of the omnidirectional optical system 100 and Figure 2 shows the light path through the panoramic component of the optical system 100. The omnidirectional optical system 100 is comprised of a primary reflector 102, a secondary reflector 104, a forward imaging lens group 106, a focusing lens group 108, an image plane 110, and an optical axis 112. The fields of view imaged by the omnidirectional optical system 100

are detailed in Figure 3. The total field of view of the omnidirectional optical system 100 comprises a forward field of view 318 seamlessly bounded by a panoramic field of view 320 that can include a significant back angle field of view 322.

In the preferred embodiment, the primary reflector 102 has a spherical geometry, with a hole through the central apex centered on the optical axis 112. The proportion of the hole diameter to the reflective spherical surface is approximately 1:4.2. The radius of curvature of the primary reflector 102 in this embodiment is 20.102 mm. The spherical geometry of the primary reflector 102 was incorporated primarily for ease of manufacturing and low cost production. More complex geometries, such as a parabolic geometry, that are more difficult to manufacture, can be incorporated as an alternative. An alternative embodiment of the present invention comprise a primary reflector 102 with alternative convex geometries, but still include the hole along the optical axis 112. In this alternative embodiment, the primary reflector 102 is a convex hyperbolic or convex parabolic reflector capable of forming a central panoramic catadioptric image. The minimal distortion caused by the focusing lens group 108 can be compensated with the correct bending power from the parabolic or hyperbolic primary reflector 102. This alternative embodiment eliminates the minimal distortion aberration that exists using the spherical geometry for the primary reflector 102.

In the preferred embodiment, the secondary reflector 104 has a flat or planar geometry, with a hole centered on the optical axis 112. The secondary reflector 104 is placed in front of the primary reflector 102 with respect to the image plane 110 and is centered along the optical axis 112. The proportion of the hole diameter to the reflective surface diameter is approximately 1:2.86. The planar reflector geometry provided an easy means of manufacturing. Alternative geometries such as concave or convex can be employed to tailor the optical system to meet specific fields of view or resolution requirements. Alternative embodiments of the present invention comprise a secondary reflector 104 with alternative convex or concave geometries, but still include the hole along the optical axis 112.

Figure 2 specifically details the ray path through the panoramic component of the omnidirectional optical system 100. Figure 2 details the rays at the boundary extremes of the panoramic field of view 320. The forward boundary ray 216 traces the path from the periphery to the primary reflector 102, to the secondary reflector 104, and through the hole along the optical axis 112 in the primary reflector 102 to the focusing lens group 108 and the image plane 110. Similarly, the rear boundary ray 214 traces the path from the periphery to the primary reflector 102, to the secondary reflector 104, and through the hole along the optical axis 112 in the primary reflector 102 to the focusing lens group 108 and the image plane 110.

An integrated function of both the primary reflector 102 and secondary reflector 104 is to ensure the seamless boundary between the forward field of view 318 and the panoramic field of view 320. The geometry and size of the primary and secondary reflectors 102,104 define the boundaries of the panoramic field of view 320 and is matched exactly to the boundary of the forward field of view 318 with no overlap and no gap. Additionally, the geometry of the primary and secondary reflectors 102,104 defines the F/# of the panoramic field of view 320. The F/# can be interpreted as the brightness in the resultant image presented on the image plane 110 and the speed of the optical system. By matching the F/# of the panoramic-only optical system (primary reflector 102 plus the secondary reflector 104) with the F/# of the forward-only optical system

(forward imaging lens group 106), the brightness appears consistent over the entire image on the image plane 110.

The forward imaging lens group 106 is designed to collect the forward field of view 318 and transfer it through the focusing lens group 108 to the image plane 110. The forward imaging lens group 106 defines the forward field of view 318 boundaries and also defines the F/# of the forward field of view 318. In the preferred embodiment of the present invention the forward field of view 318 spans approximately 80 degrees, +/- 40 degrees about the optical axis 112. The forward imaging lens group 106 is placed directly behind the secondary reflector 104 with respect to the image plane 110 and it is centered on the optical axis 112. In the preferred embodiment the lens elements in the forward imaging lens group 106 are spherical optical components fabricated of conventional optical materials such as BK7. The use of spherical optics and conventional materials lends to lower fabrication costs and cost effective system implementation.

The focusing lens group 108 is centered along the optical axis 112 and is placed in between the primary reflector 102 and the image plane 110. The focusing lens group 108 collects the panoramic field of view 320 from the secondary reflector 104 and the forward field of view 318 from the forward imaging lens group 106. It is the function of the focusing lens group 108 to focus the two independent optical paths from the panoramic field of view 320 and the forward field of view 318 onto a single image plane 110 and to control the image aberrations on this coplanar image. In the preferred embodiment of the present invention the primary reflector 102 is not solid and houses a portion of the focusing lens group 108 in the concave underside of its reflective surface. In the preferred embodiment the lens elements in the focusing lens group 108 are spherical optical components fabricated of conventional optical materials such as BK7. The use of spherical optics and conventional materials lends to lower fabrication costs and cost effective system implementation.

Image Plane

The forward field of view 318 and panoramic field of view 320 are integrated on a single image plane 110 to be presented as a single image. Figure 4 shows a schematic representation of the integrated image on the image plane 110 with the coplanar presentation of the forward field of view 318 and the panoramic field of view 320. The coplanar single image presents many options for post processing not available to imaging systems that require panning and tilting to cover the same total field of view. Image processing techniques can be employed to remap the image plane 110 and present it to the user in a variety of formats. The image plane 110 is the focus of the coplanar integration of the forward field of view 318 and the panoramic field of view 320. As shown in the figure the forward field of view 318 is concentrically presented with the panoramic field of view 320. Although a boundary between the forward field of view 318 and the panoramic field of view 320 is designated on the schematic in Figure 3, it is there only to designate the difference between the image collected by the forward imaging lens group 106 and that collected by the primary reflector 102. In actuality the omnidirectional optical system 100 produces a continuous image on the image plane 110 in which the boundary between the fields of view is not evident. The image plane 110 would typically be a visible or near-infrared imaging detector such as a CCD or CMOS camera or detector. The preferred embodiment of the present invention is optimized for integration with a 640 x 480 output file size on a 1/3" format sensor. Alternative embodiments of the present invention comprise the present omnidirectional

optical system **100** optimized for visible and near-IR sensors of various sizes and resolutions. The sensors can either be analog or digital and can range from the lowest resolution, approximately 160 x 120 pixels to the highest resolution, which at this time is greater than a 6 megapixel array.

Fields of View

The present invention provides an omnidirectional optical system **100** that provides a substantially hyper-hemispherical field of view that extends to a maximum 270 degrees azimuthally and 360 degrees peripherally as shown in Figure 3. This field of view is achieved by integrating a forward field of view **318** with a panoramic field of view **320** on a single image plane **110**. The forward and panoramic fields of view **318**, **320** are non-overlapping and there is no blind spot or gap between them. The boundaries of the forward and panoramic fields of view **318**, **320** are relatively parallel. The forward field of view **318** extends about 80 degrees total (+/- 40 degrees from the optical axis). The panoramic field of view **320** extends about 95 degrees (50 degrees above the horizon and 45 degrees below the horizon). The magnification is matched between the forward and panoramic fields of view **318**, **320** and the F/# is matched between the forward and panoramic fields of view **318**, **320**. The image formed on the image plane **110**, therefore, seems continuous, with no differences in brightness or size, and no distortion at the seamless boundaries. The geometry of the primary reflector **102** and the secondary reflector **104** defines the extent of the panoramic field of view **320**. Similarly the optical design of the forward imaging lens group **106** defines the extent of the forward field of view **318**. The extent of each the forward field of view **318** and the panoramic field of view **320** can be tailored to meet the exact specifications of the application in which the omnidirectional optical system **100** is being used.

Size and Materials

The invention has been demonstrated at a diameter of approximately 40 mm and a height of 62.5 mm for a omnidirectional optical system **100** optimized for a visible light imager. The invention can be scaled in diameter to accommodate different application requirements. It has been scaled to a diameter of 2.7 mm for endoscope / borescope applications. The exact specification of materials is application dependent. However, the preferred embodiment comprises a primary reflector **102** that is BK7 glass with a protected aluminum coating, a secondary reflector **104** made of polished aluminum, and all optical elements in the forward imaging lens group **106** and the focusing lens group **108** made of standard glass with an antireflection coating deposited on them.

Alternative Embodiments

Aside from the alternative embodiments listed above relating to individual component specification and application customization an additional embodiment is listed below. One alternative embodiment of the present invention comprises the omnidirectional optical system **100** optimized for integration with an infrared imaging sensor for thermal or far-infrared imaging, such as but not limited to an uncooled microbolometer or a focal plane array. This detector would be inserted at the image plane **110** of the optical system **100**. The wavelength differences in the signal being transmitted and processed require different optical materials, which have different optical properties and a system optimized to the microbolometer size and resolution. At this time the highest resolution far infrared uncooled microbolometer is 320x240 pixels. Specifically, distinct changes in the optical materials are necessary to account for the infrared band of the electromagnetic spectrum. The primary reflector **102** and the secondary reflector **104**

will be coated in gold. This is the standard for IR reflective coatings and is widely available from optical manufacturers. The choice of materials for the optical elements in the forward imaging lens group 106 and the focusing lens group 108 include Zinc Selenide (ZnSe), Sodium Chloride (NaCl) and Cesium Bromide (CsBr).

An additional alternative embodiment of the present invention is implementation of the omnidirectional optical system in a non-imaging application for omnidirectional free space communication. This alternative embodiment in which the omnidirectional optical system 100 is used as an omnidirectional optical antenna is depicted in Figure 5.

The primary components of the omnidirectional optical system 100 remain the same in this alternative embodiment and comprise the primary reflector 102, the secondary reflector 104, the forward lens group 106 and the focusing lens group 108. In this embodiment, the primary reflector 102 and the secondary reflector 104 are used as large area light collectors to feed light from the panoramic field of view 320 into the focusing lens group 108. Second, the forward lens group 106 is used as a wide-angle objective to bend the light from the wide-angle forward field of view 318 into the focusing lens group 108. Third, the focusing lens group 108 comprises a set of front positive lenses and a set of rear negative lenses.

In this alternative embodiment, the optical system will be converted to an afocal system. This modification will include only the focusing lens group 108. The image plane 110 will be set at infinity, which is represented by the rays emanating from the focusing lens group 108 in Figure 5. The afocal magnification will be maintained at an optimized level, which will depend on the detector/transmitter size and the overall dimensions of the optical system.

In this alternative embodiment, a diffraction limited optical system design is required for this long-range optical communication antenna application, especially for high data rate communication systems. If the design is not diffraction limited, wavefront errors may overlap the adjacent optical signals and confuse the decision-making circuits when the data rate reaches a certain level. The optical system forms the transmit beam and any errors will degrade the beam quality. The diffraction limit of the design is associated with the Rayleigh quarter wave criterion. It means the system wavefront error must be controlled around $0.075 (\lambda/13.3)$ waves. Optimization on lens configuration for the forward lens group 106 and the focusing lens group 108 and glass materials selection.

In this alternative embodiment, the image plane / detector plane 110 must be distortion free for the optical antenna application. For an afocal optical system, the power distribution on the image plane 110 is expected to be constant across the total field of view, which comprises the forward field of view 318 plus the panoramic field of view 320. Any distortion will alter the transmitter power distribution, and will saturate the detector or weaken the signal strength. As mentioned above, the distortion free omnidirectional optical design is achievable by using either a convex hyperbolic or a convex parabolic mirror as the primary reflector 102.

A final alternative embodiment of the present invention is implementation of the omnidirectional optical system 100 with directional zooming. Due to the unique configuration of the omnidirectional optical system 100, directional zooming in the panoramic field of view 320 can be achieved by tilting the primary reflector 102, which is typically spherical or alternatively parabolic. This alternative embodiment is represented

in Figure 6. By tilting the primary reflector **102** in the direction of interest, it changes the area on the primary reflector **102** that the image rays strike and the total path length, thereby changing the size of the image on the image plane **110**. The forward field of view **318** would either move away from the center of the image plane **110** or completely out of view, depending on the degree of tilt of the primary reflector **102**. However, this would not be a factor in the imaging since the zoomed area is the area of interest. It is expected that this configuration can achieve at least a 5x zoom on the area of interest. Additionally, directional zooming can be achieved in the forward field of view **318** by moving at least one of the elements of the forward viewing lens group **106** along the optical axis **110**.

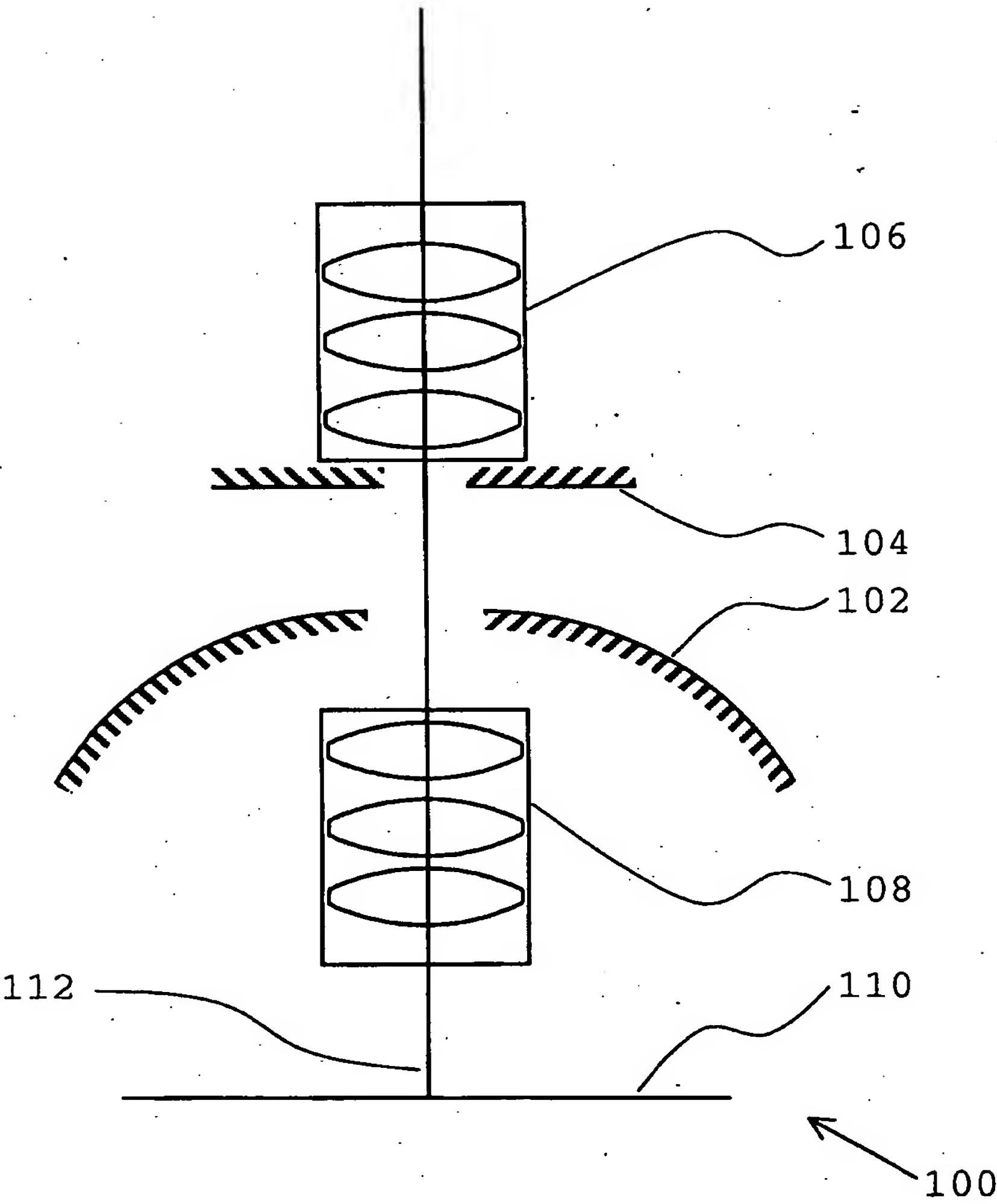


Figure 1

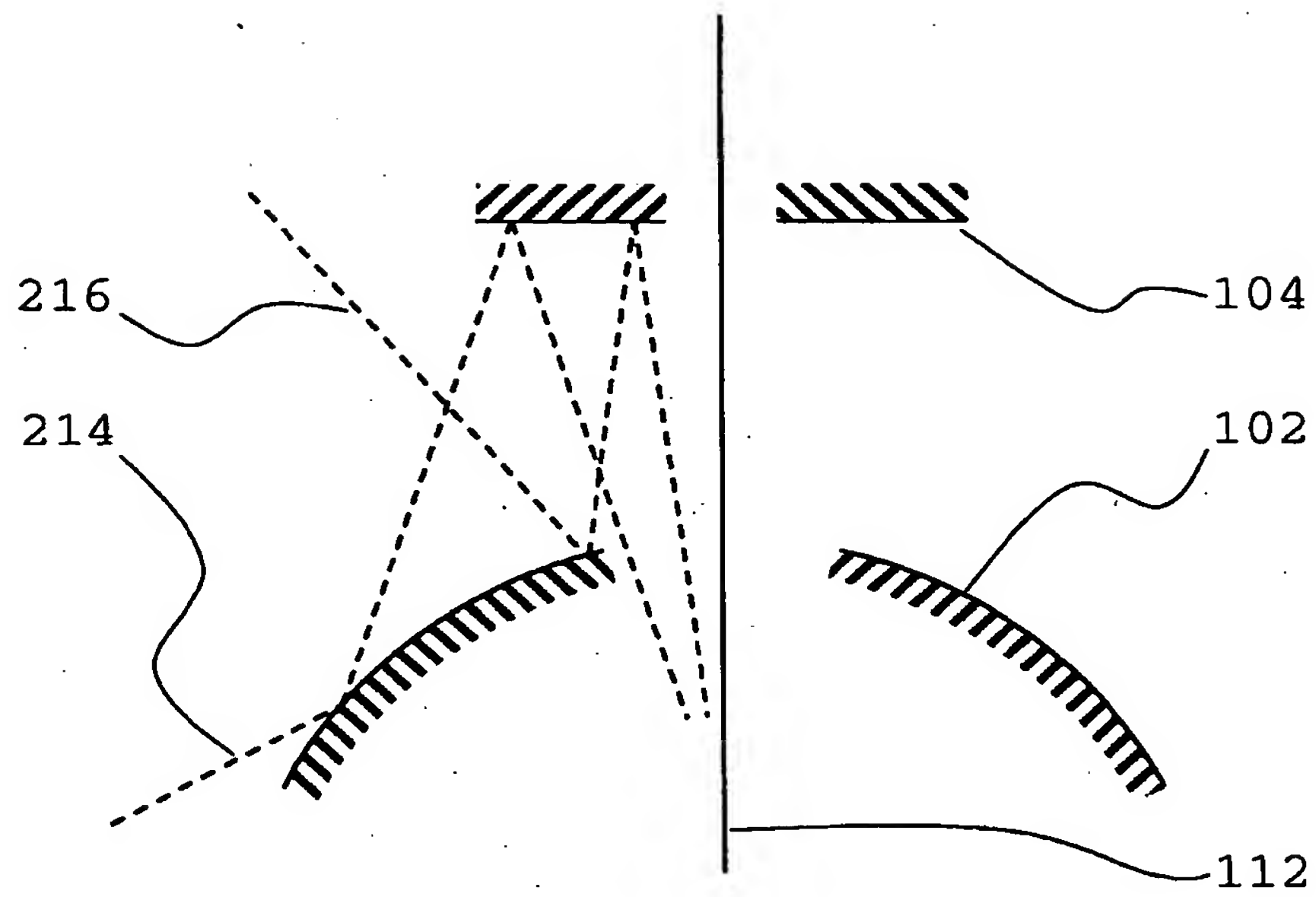


Figure 2

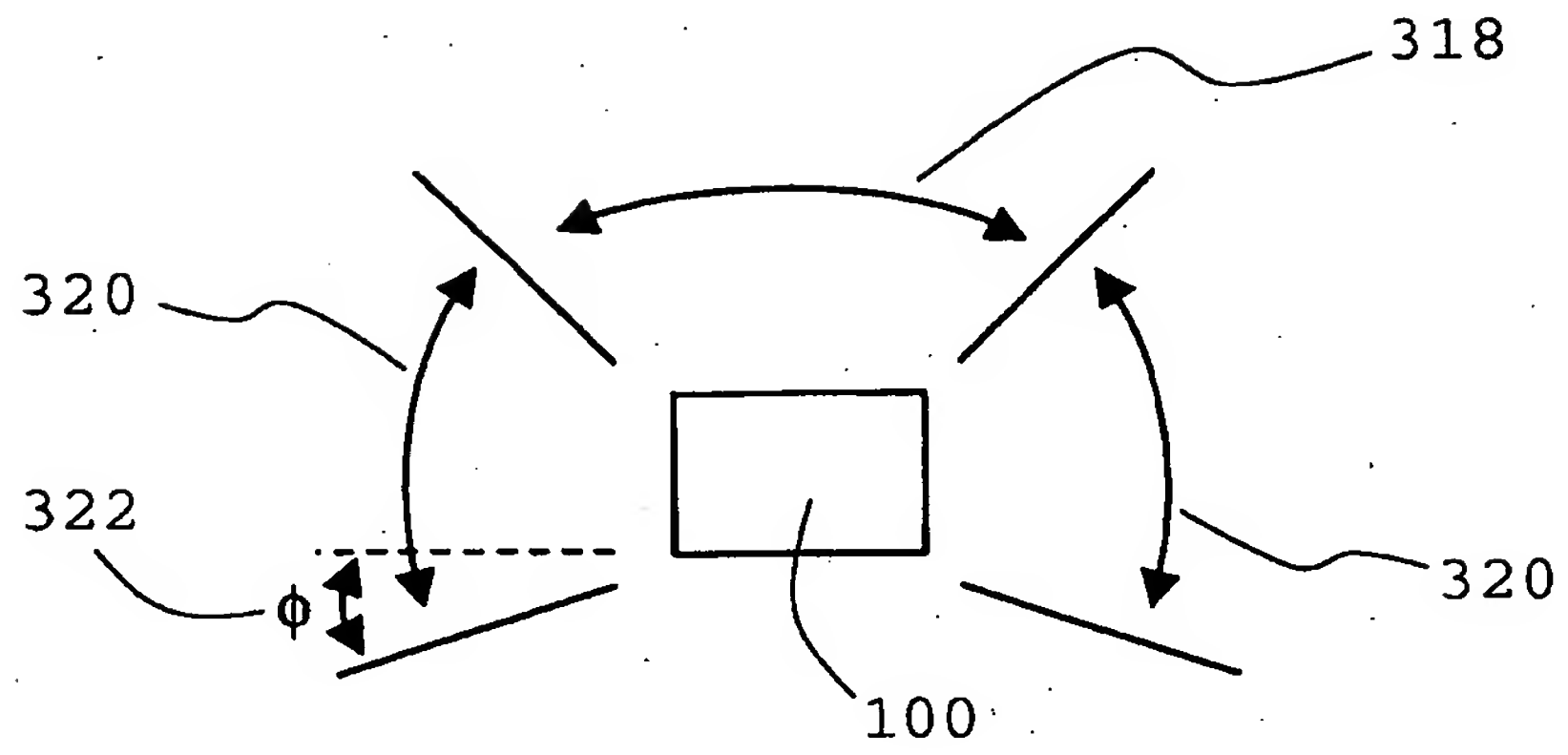


Figure 3

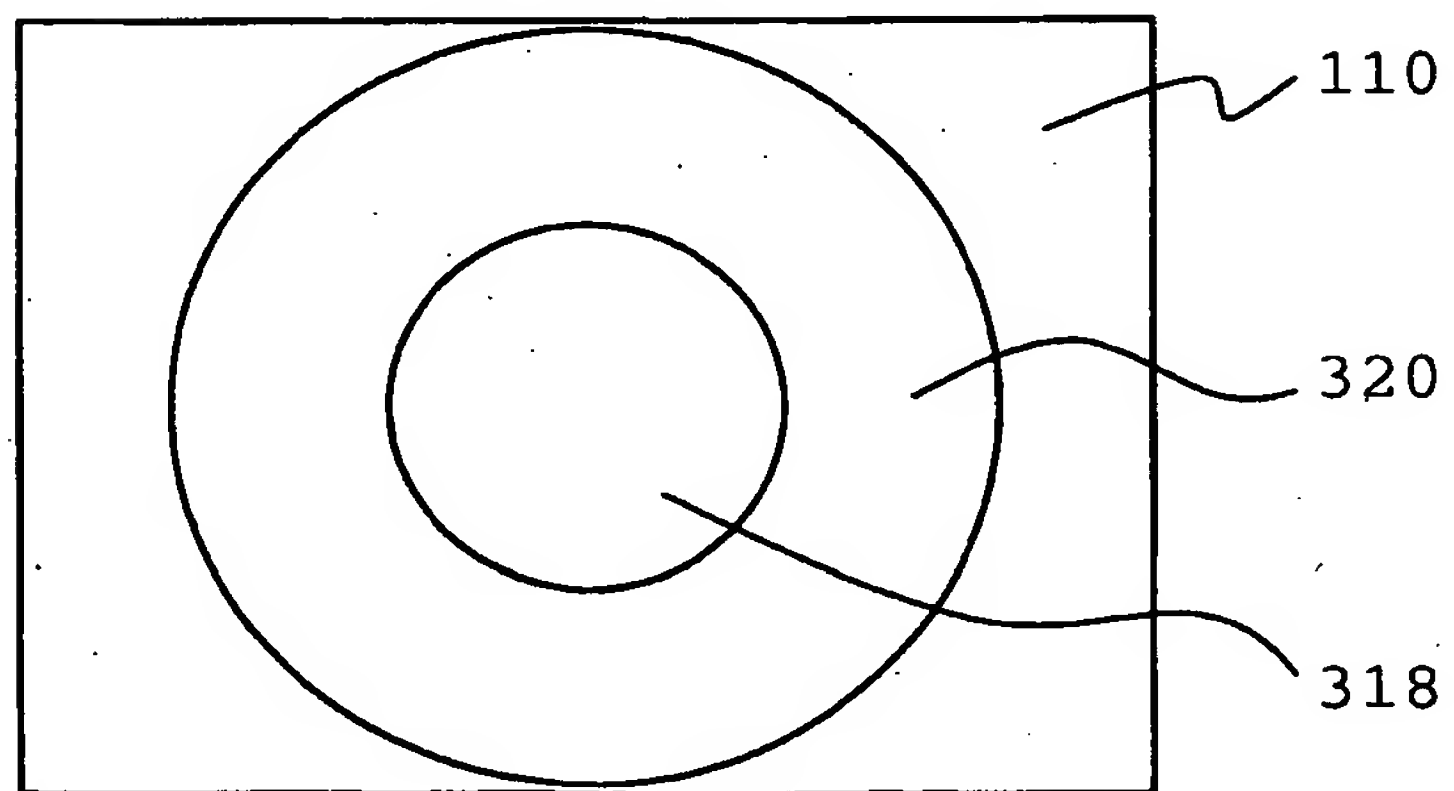


Figure 4

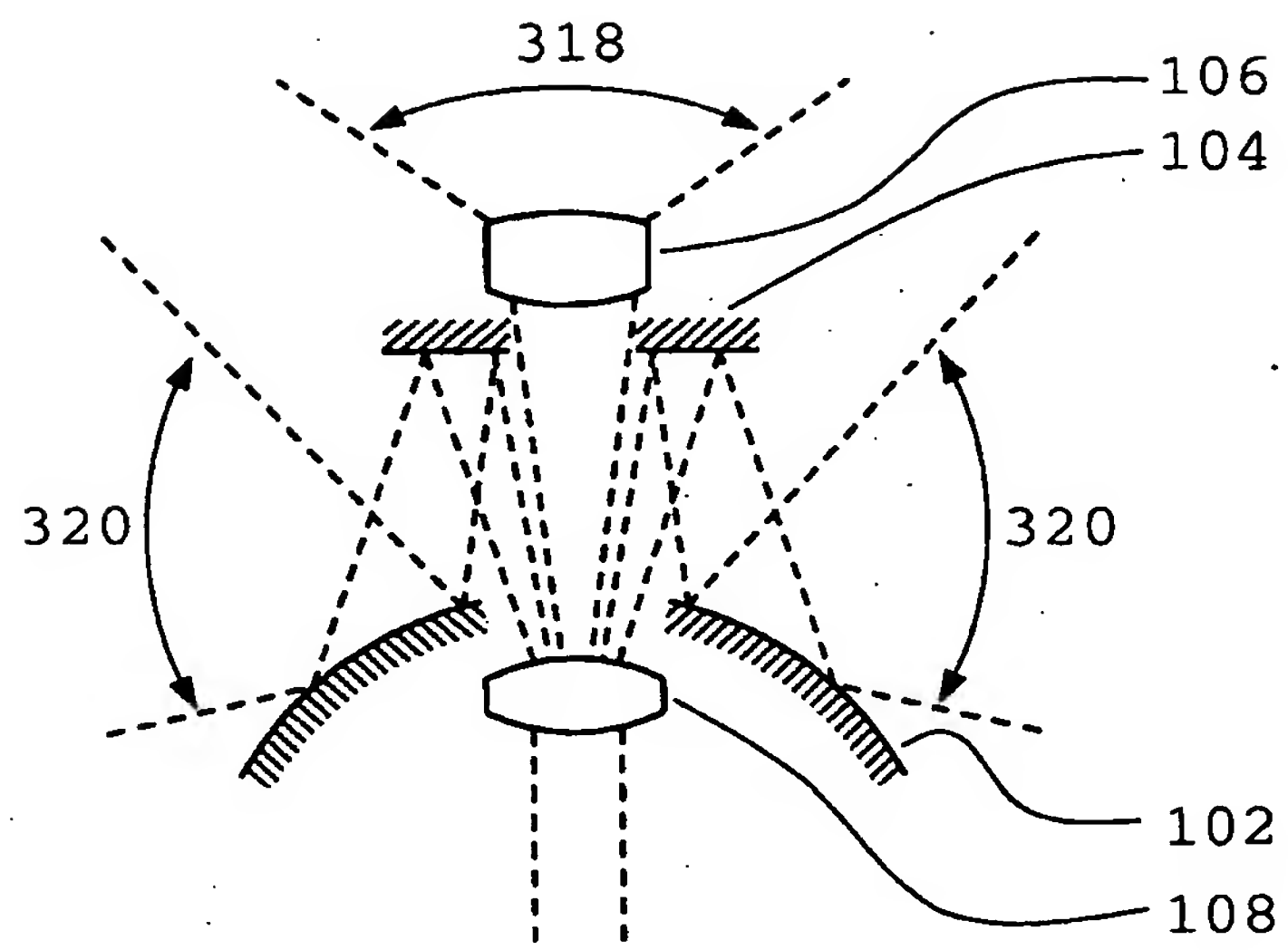


Figure 5

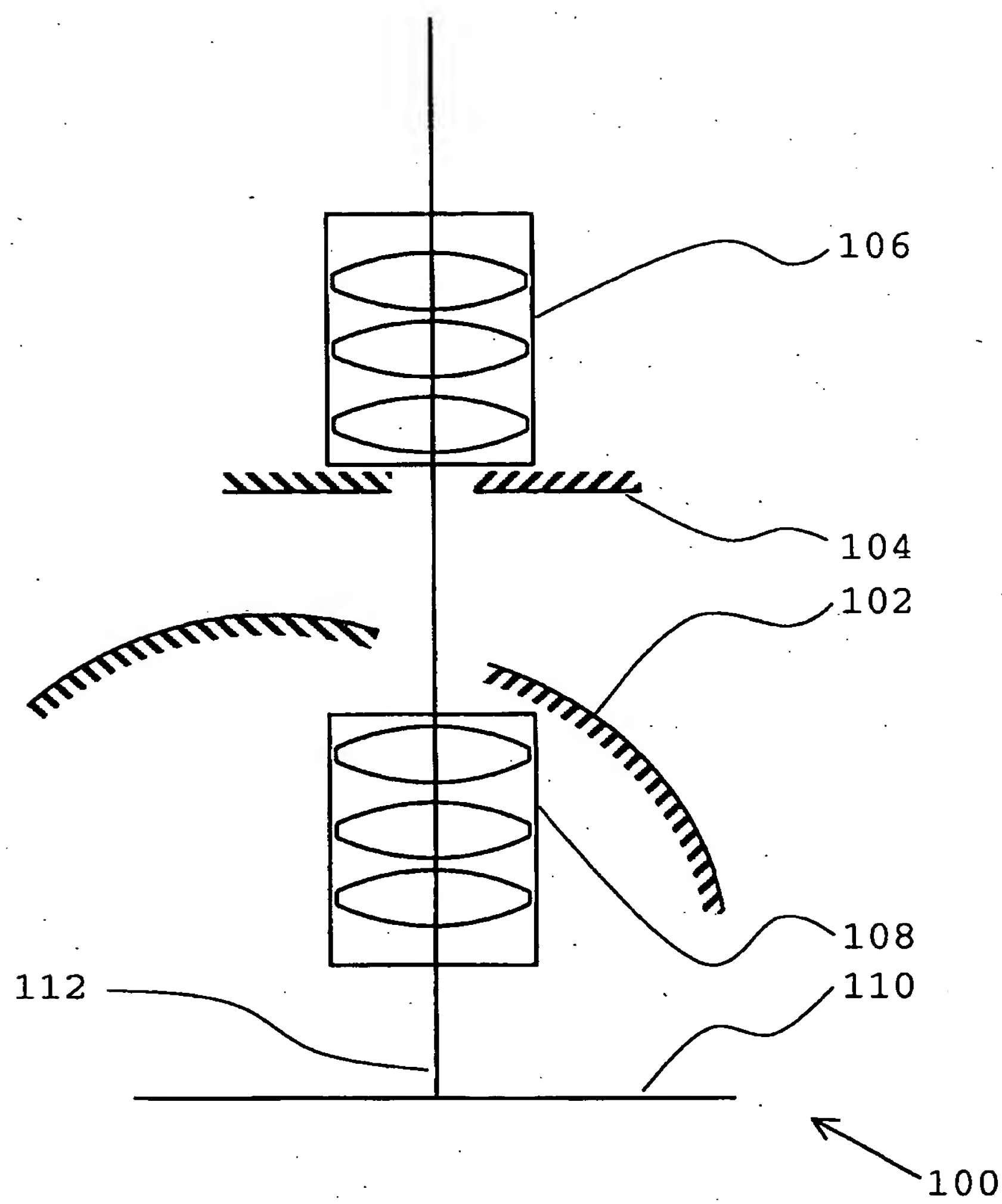


Figure 6

Box No. VIII (iii) DECLARATION: ENTITLEMENT TO CLAIM PRIORITY

The declaration must conform to the standardized wording provided for in Section 213; see Notes to Boxes Nos. VIII, VIII (i) to (v) (in general) and the specific Notes to Box No. VIII (iii). If this Box is not used, this sheet should not be included in the request.

Declaration as to the applicant's entitlement, as at the international filing date, to claim the priority of the earlier application specified below, where the applicant is not the applicant who filed the earlier application or where the applicant's name has changed since the filing of the earlier application (Rules 4.17(iii) and 51bis.1(a)(iii)):

In relation to this international application, InterScience, Inc. is entitled to claim priority of earlier application (US provisional 60/542,736) by virtue of the following:

- (i) Michelle Simkulet of Cohoes, New York is an inventor of the subject matter for which protection is sought by way of this international application, and
- (ii) InterScience, Inc. is entitled as employer of the inventor, Michelle Simkulet, and
- (iv) Assignments from Michelle Simkulet to InterScience, Inc. dated 06 February 2004 and 02 February 2005.

(ix) This declaration is made for the purpose of all designations.

- (i) Jiayin Ma of Newtonville, New York is an inventor of the subject matter for which protection is sought by way of this international application, and
- (ii) InterScience, Inc. is entitled as employer of the inventor, Jiayin Ma, and
- (iv) Assignments from Jiayin Ma to InterScience, Inc. dated 06 February 2004 and 02 February 2005.

(ix) This declaration is made for the purpose of all designations.

- (i) Jason E. Smith of Latham, New York is an inventor of the subject matter for which protection is sought by way of this international application, and
- (ii) InterScience, Inc. is entitled as employer of the inventor, Jason E. Smith and
- (iv) Assignments from Jason E. Smith to InterScience, Inc. dated 06 February 2004 and 02 February 2005.

(ix) This declaration is made for the purpose of all designations.

☐ This declaration is continued on the following sheet, "Continuation of Box No. VIII (iii)".

Box No. VIII (ii) DECLARATION: ENTITLEMENT TO APPLY FOR AND BE GRANTED A PATENT

The declaration must conform to the standardized wording provided for in Section 212; see Notes to Boxes Nos. VIII, VIII (i) to (v) (in general) and the specific Notes to Box No. VIII (ii). If this Box is not used, this sheet should not be included in the request.

Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent (Rules 4.17(ii) and 51bis.1(a)(ii)), in a case where the declaration under Rule 4.17(iv) is not appropriate:

in relation to this international application, InterScience, Inc. is entitled to apply for and be granted a patent by virtue of the following:

- (i) Michelle Simkulet of Cohoes, NY is an inventor of the subject matter for which protection is sought by way of this international application, and
- (ii) InterScience, Inc. is entitled as employer of the inventor Michelle Simkulet, and
- (iv) assignments from Michelle Simkulet dated 06 February 2004 and 02 February 2005.
- (ix) This declaration is made for the purpose of all designations [except the designation of the United States of America].

- (i) Jiayin Ma of Newtonville, NY is an inventor of the subject matter for which protection is sought by way of this international application, and
- (ii) InterScience, Inc. is entitled as employer of the inventor Jiayin Ma, and
- (iv) assignments from Jiayin Ma dated 06 February 2004 and 02 February 2005.
- (ix) This declaration is made for the purpose of all designations [except the designation of the United States of America].

- (i) Jason E. Smith of Latham, NY is an inventor of the subject matter for which protection is sought by way of this international application, and
- (ii) InterScience, Inc. is entitled as employer of the inventor Jason E. Smith, and
- (iv) assignments from Jason E. Smith dated 06 February 2004 and 02 February 2005.
- (ix) This declaration is made for the purpose of all designations [except the designation of the United States of America].

☐ This declaration is continued on the following sheet, "Continuation of Box No. VIII (ii)".

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

REC'D 31 MAY 2005

PCT

WIPO

PCT

To:

see form PCT/ISA/220

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY (PCT Rule 43bis.1)

Date of mailing
(day/month/year) see form PCT/ISA/210 (second sheet)

Applicant's or agent's file reference
see form PCT/ISA/220

FOR FURTHER ACTION
See paragraph 2 below

International application No.
PCT/US2005/003215

International filing date (day/month/year)
03.02.2005

Priority date (day/month/year)
06.02.2004

International Patent Classification (IPC) or both national classification and IPC
G02B13/06, G02B17/08

Applicant
INTERSCIENCE, INC.

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. FURTHER ACTION

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA"). However, this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of three months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA:



European Patent Office
D-80298 Munich
Tel. +49 89 2399 - 0 Tx: 523656 epmu d
Fax: +49 89 2399 - 4465

Authorized Officer

Casse, M

Telephone No. +49 89 2399-2769



**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.
PCT/US2005/003215

Box No. I Basis of the opinion

1. With regard to the language, this opinion has been established on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.
☐ This opinion has been established on the basis of a translation from the original language into the following language , which is the language of a translation furnished for the purposes of international search (under Rules 12.3 and 23.1(b)).
2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application and necessary to the claimed invention, this opinion has been established on the basis of:
 - a. type of material:
☐ a sequence listing
☐ table(s) related to the sequence listing
 - b. format of material:
☐ in written format
☐ in computer readable form
 - c. time of filing/furnishing:
☐ contained in the international application as filed.
☐ filed together with the international application in computer readable form.
☐ furnished subsequently to this Authority for the purposes of search.
3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
4. Additional comments:

**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.
PCT/US2005/003215

Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, Inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	11,19,34,42
	No: Claims	1-10,12-18,20-33,35-41,43-46
Inventive step (IS)	Yes: Claims	19,42
	No: Claims	1-18,20-41,43-46
Industrial applicability (IA)	Yes: Claims	1-46
	No: Claims	

2. Citations and explanations

see separate sheet

Re Item V.

1 Reference is made to the following documents:

D1 : GB 867 251 A (THE GENERAL ELECTRIC COMPANY LIMITED) 3 May 1961
(1961-05-03)

D2 : US 2002/121574 A1 (DAVIS JOHN E) 5 September 2002 (2002-09-05)

D3 : WO 02/059676 A (WAVEGROUP LTD; GAL, EHUD; LITEYGA, GENNADIY;
EYAL, REUVEN) 1 August 2002 (2002-08-01)

D4 : WO 03/096078 A (SPHEREVIEW LTD; GAL, EHUD) 20 November 2003
(2003-11-20)

D5 : EP 0 816 891 A (HE HOLDINGS, INC. DBA HUGHES ELECTRONICS;
RAYTHEON COMPANY) 7 January 1998 (1998-01-07)

D6 : WO 03/042743 A (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD;
MATSUKI, DAIZABURO; YOSHIKAWA) 22 May 2003 (2003-05-22) interpreted
on the basis of family member EP1452899.

2) INDEPENDENT CLAIM 1

2.1) The present application does not meet the criteria of Article 33(1) PCT, because the
subject-matter of claim 1 is not new in the sense of Article 33(2) PCT.

Document D1 discloses (the references in parentheses applying to this document):

An apparatus (figure 1) integrating forward and panoramic field (page1, lines 62-72),
comprising:

a primary reflector 1 having a convex surface in relation to the forward field, at least
part of its surface being reflective2, and having a primary reflector hole 3 centered on
the optical axis,

a secondary reflector 6, forward of the primary reflector relative to the forward field, at
least part of its surface being reflective 4 and having a secondary hole in the
reflecting surface 6 centered on said reflector axis.

2.2) Similar apparatuses which also take away the novelty of the subject matter of claim 1
are shown:

In D2, figure 4, with primary reflector 32 and secondary reflector 30.

In D3, figures 1a and 1b, with primary reflector 25 and secondary reflector 20.

In D4, figures 4 and 6, see paragraph bridging page 14 and 15.

In D5, figure 3 with table 5.

In D6, figures 29 and 31.

3.) DEPENDENT CLAIMS 2-23, 25-40, 42-46

Dependent claims 2-19, 20 to 23 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of novelty and/or inventive step (Article 33(2) and (3) PCT). see documents D1 to D6 and the corresponding passages cited in the search report. In summary:-

Claims 2,4,6: see D3 figure 33 as an example.

Claim 3 see D6 family document paragraphs 148-151

Claim 5 afocal elements are suggested in D1 by the hint at periscopic systems page 2 lines 121-127.

Claim 7 see D3 figure 1c for example

Claims 8 to 10 and 20 to 23 are obvious features or uses for optical or reflecting apparatuses, D5 is also used in the IR range.

Claims 12 to 14, the primary of D1 is spherical but hints at other aspherical surfaces, D3 page 26 lines 3 to 10 discloses all surface shapes.

The second aperture in D6 appears larger than the first hole.

Claim 16 see D3

Claim 17 see D2

Claim 18 see D1

4.) The combination of the features of dependent claims 19 and 42 is neither known from, nor rendered obvious by, the available prior art. The reasons are as follows:

None of the panoramic cameras with forward looking optics disclose the possibility to tilt the primary mirror in this configuration. This allows to decenter the central field of view relatively to the circumferential imaged field.

5.) Method claims 24 to 46 mirror exactly the apparatus claims 1 to 23 and the above

**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING
AUTHORITY (SEPARATE SHEET)**

International application No.

PCT/US2005/003215

objections and comments apply mutatis mutandis to these claims.

From the INTERNATIONAL BUREAU

PCTNOTIFICATION CONCERNING
SUBMISSION OR TRANSMITTAL
OF PRIORITY DOCUMENT

(PCT Administrative Instructions, Section 411)

To:

YABLON, Jay, R.
Yablon Law Office
910 Northumberland Drive
Schenectady, NY 12309
ETATS-UNIS D'AMERIQUE

Date of mailing (day/month/year) 14 April 2005 (14.04.2005)	
Applicant's or agent's file reference	IMPORTANT NOTIFICATION
International application No. PCT/US05/003215	International filing date (day/month/year) 03 February 2005 (03.02.2005)
International publication date (day/month/year)	Priority date (day/month/year) 06 February 2004 (06.02.2004)
Applicant	INTERSCIENCE, INC. et al

1. By means of this Form, which replaces any previously issued notification concerning submission or transmittal of priority documents, the applicant is hereby notified of the date of receipt by the International Bureau of the priority document(s) relating to all earlier application(s) whose priority is claimed. Unless otherwise indicated by the letters "NR", in the right-hand column or by an asterisk appearing next to a date of receipt, the priority document concerned was submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b).
2. (If applicable) The letters "NR" appearing in the right-hand column denote a priority document which, on the date of mailing of this Form, had not yet been received by the International Bureau under Rule 17.1(a) or (b). Where, under Rule 17.1(a), the priority document must be submitted by the applicant to the receiving Office or the International Bureau, but the applicant fails to submit the priority document within the applicable time limit under that Rule, the attention of the applicant is directed to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.
3. (If applicable) An asterisk (*) appearing next to a date of receipt, in the right-hand column, denotes a priority document submitted or transmitted to the International Bureau but not in compliance with Rule 17.1(a) or (b) (the priority document was received after the time limit prescribed in Rule 17.1(a) or the request to prepare and transmit the priority document was submitted to the receiving Office after the applicable time limit under Rule 17.1(b)). Even though the priority document was not furnished in compliance with Rule 17.1(a) or (b), the International Bureau will nevertheless transmit a copy of the document to the designated Offices, for their consideration. In case such a copy is not accepted by the designated Office as the priority document, Rule 17.1(c) provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

<u>Priority date</u>	<u>Priority application No.</u>	<u>Country or regional Office or PCT receiving Office</u>	<u>Date of receipt of priority document</u>
06 February 2004 (06.02.2004)	60/542,736	US	03 March 2005 (03.03.2005)

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. +41 22 740 14 35	Authorized officer Muller Leonard Facsimile No. +41 22 338 89 95 Telephone No. +41 22 338 8817
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